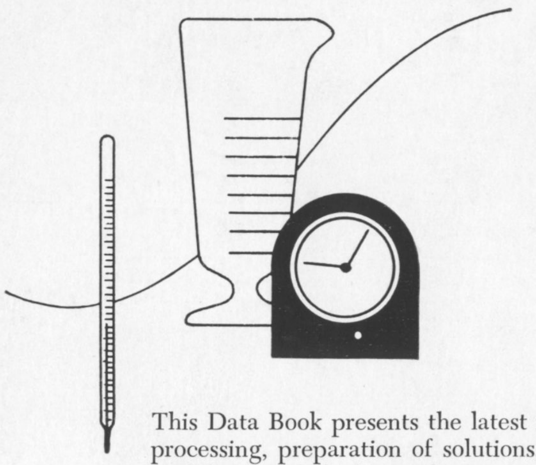

FIFTH EDITION

PROCESSING

CHEMICALS and FORMULAS

FIRST 1959 PRINTING

This Data Book presents the latest information and techniques on processing, preparation of solutions, formulas, and descriptions of Kodak prepared chemicals. Keeping qualities and other characteristics of these solutions are given, together with instructions for their use.

This is one of a series of Kodak Data Books on black-and-white and color photography. The scope embraces techniques, processes, and materials in the amateur, professional, industrial, scientific, and graphic arts fields. Each Data Book is a self-contained unit, punched to fit a Mult-O Ring binder.

The Kodak Handbooks

There are six main reference books on Kodak products, processes, and techniques. Each consists of an attractive, metal-ring, stiff-covered binder containing the basic Data Books relating to one particular field, tabbed separators for indexing, space for additional Data Books and free Kodak literature, and a registration card. Filling out and returning the registration card entitles you to receive an illustrated newsletter, published several times a year, or free literature, to keep you informed on Kodak techniques, materials, and processes or new and revised publications as they become available. You can keep your handbook up to date by replacing sections superseded by new editions of Kodak Data Books. These are available from your Kodak dealer.

Handbooks now published by Kodak are: the *Kodak Reference Handbook Volume 1 and Volume 2,* the *Kodak Color Handbook,* the *Kodak Professional Handbook,* the *Kodak Industrial Handbook,* and the *Kodak Graphic Arts Handbook.* The matching *Kodak Photographic Notebook* is useful for organizing additional Data Books and material on related photographic subjects.

PROCESSING

CHEMICALS AND FORMULAS

Page
PROCESSING PRINCIPLES 4
  Composition of the Developer 4
  Factors Affecting Degree of Development 4
    Time of Development 4
    Temperature of Developer Solution 5
    Agitation of the Developer 5
    Activity of the Developer Solution 6
  Replenishers 6
  Stop Baths 7
  Fixing Baths 7
    Time of Fixing 8
    Testing Stop Baths and Fixing Baths 8
  Necessity for Washing 9
    Time for Complete Washing 9
PREPARATION OF SOLUTIONS 10
  Water Supply 10
  Types of Containers 11
  Cleanliness 11
  Mixing Solutions 11
  Measurement of Small Quantities 12
  Storing Solutions 13
  Cleaning Processing Apparatus 14
PROCESSING TECHNIQUE 16
  Processing of Films and Plates 16
    Tank Development: Roll, Pack, and Small Sheet Films 16
    Tank Development: Sheet Films and Plates 17
    Tray Development—Roll Films 18
    Tray Development—Single Sheet Film or Plate 18
    Tray Development—Several Sheet Films 19
    Tray Development—Several Plates 20
  Drying Films and Plates 21
  Development Times 21
  Rapid Film Processing 22
  High-Temperature Processing 23
  Time-Temperature Development Charts 24
  Processing of Papers 25
  Toning 27
INDEX TO CHEMICALS AND FORMULAS 29
USE OF SAFELIGHTS 66

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FIFTH EDITION 1954
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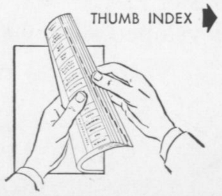
THUMB INDEX ➧



CHEMICALS AND FORMULAS
PROCESSING PRINCIPLES
Development
Fixing
Washing
HANDLING SOLUTIONS
Mixing
Storing
Cleaning Apparatus
PROCESSING TECHNIQUE
Films and Plates
Rapid Processing
High-Temperature Development
Papers
Toning

PROCESSING
CHEMICALS AND FORMULAS
FOR BLACK-AND-WHITE PHOTOGRAPHY

• A photographic material consists of a mechanical support, such as film, glass, or paper, on which is coated a light-sensitive emulsion made up of minute crystals of a silver halide (usually bromide, chloride, or both) suspended in gelatin. When the material is exposed to light in a camera, printer, or enlarger, there is no visible effect, but it is certain that there must be some invisible change which produces what is called a "latent image." In order to obtain a visible, usable image, the exposed material must be developed, fixed, and washed.

When the exposed photographic material is placed in a developer solution, the developer attacks the exposed grains which contain the latent-image material, freeing the silver from its compound and depositing it as tiny, irregular grains of metallic silver. The multitudes of these minute grains form the black silver image. The developer will also attack the unexposed grains, but much more slowly, so that only a relatively small amount of silver (fog density) is formed in the unexposed areas for a normal time of development.

After development is completed, the undeveloped silver halide crystals remaining in the emulsion must be removed in order to keep them from darkening and obscuring the image. This "fixing" is accomplished by treating the emulsion in a solution of sodium or ammonium thiosulfate, or "hypo," which forms a soluble compound with the silver halide but has practically no effect on the silver image under normal conditions of use.

After the undeveloped silver halide has been dissolved, the emulsion is still saturated with the chemicals of the fixing bath and some of the dissolved silver salts. If these were allowed to remain, they would slowly decompose and cause fading and staining of the image. To produce stable prints or negatives, the hypo and silver salts must be removed by washing.

Photography, then, is essentially a chemical process which involves many complex reactions of chemicals in solution. These reactions determine, to a great degree, the properties and qualities of the photographic images. Therefore, the purity, strength, and uniformity of the chemicals and the manner in which they are combined are of utmost importance in achieving results of uniformly high quality.

Photographers rarely have the time or experience necessary to analyze and test their processing solutions. Their interest is in the finished photograph, and they rely on the uniformity and dependability of the materials they use to produce the desired result.

Because of these facts, and to meet the demand for formulas and chemicals from which results of uniformly high quality could be expected, Kodak formulas were evolved and Kodak Tested Chemicals were introduced.

In order to assure accurately compounded solutions, and to save time for the darkroom worker, the Eastman Kodak Company makes available many packaged chemical preparations which need only to be dissolved or diluted according to the directions on the package. Some of these packaged preparations are made according to published formulas and are designated by the formula numbers. Other preparations, identified by trade-marked names, are not identical with any published formulas, though in many cases their photographic properties are similar to those of certain popular formulas.

These named preparations are free from many of the limitations of published formulas. A single product may contain many component parts, including chemicals which are not ordinarily stocked by dealers. When research points the way toward product improvement, changes in quantities or in the constituents themselves can be made without delay or inconvenience.

Before Kodak chemical preparations reach the market, they are already darkroom veterans. Where pertinent, they are tested for reaction to humidity, heat, and cold; for resistance to aeration; for capacity, ease of mixing, clarity of solution, and useful life. Practical tests are made in several independent departments, as well as in the Kodak Research Laboratories. As a final check, trade tests are made in selected areas, and customer reaction is studied carefully.

Processing Principles

COMPOSITION OF THE DEVELOPER SOLUTION

There are many different formulas for developer solutions, but almost all practical formulas contain four essential constituents: developing agent, accelerator, preservative, and restrainer.

The developing agent reduces the silver from its compound to form the image. The most important agents, which are used singly or in combination, are Kodak Elon Developing Agent and hydroquinone. An alkali, such as sodium carbonate, borax, Kodalk Balanced Alkali, or sodium or potassium hydroxide, is added as the accelerator to make the developing agent become sufficiently active. The preservative, sodium sulfite, is necessary to minimize the effect of aerial oxidation of the developing agent and tends to maintain the solution colorless during mixing and storing. Many formulas also require a small quantity of potassium bromide to restrain the developer from acting on the unexposed silver halide crystals and thereby producing general fog. In addition to these main constituents, developer solutions often contain other substances, such as sodium bisulfite, sodium sulfate, alcohol, etc., added for special purposes.

FACTORS AFFECTING DEGREE OF DEVELOPMENT

The density obtained in a developed image depends on the nature of the emulsion, the exposure that it has received, and the degree of development. With any particular emulsion, the degree of development depends on the time of development, the temperature of the developer, the degree of agitation of the material or developer solution, and the activity of the developer, which is determined by the composition and dilution of the solution and the degree of exhaustion.

Time of Development. When the exposed material is placed in the developer, the solution penetrates the emulsion and begins to reduce the exposed crystals to metallic silver. The longer the development is carried on, the more silver is formed and the blacker the image becomes; the density difference between highlight and shadow areas also increases.

In the case of negative materials, the degree of development is measured by the slope of the straight-line portion of the characteristic curve of the material. This value is known as "gamma."

If development is carried too far, the density may become too high, and the developer may begin to act on the unexposed silver bromide crystals; this causes "developer fog" which tends to veil the details in the shadows. Development should be stopped when the desired gradient or gamma has been reached. Since the desired degree of development may vary somewhat in different cases, time-gamma curves are usually given in film specifications so that the proper development time can be selected for particular circumstances.

Temperature of Developer Solution. The rate of development is affected by the temperature of the solution. As the temperature rises, the rate of development increases. Thus, when the developer temperature is low, the reaction is slow and the development time recommended for the normal temperature would give underdevelopment; when the temperature is high, the reaction is fast and the same time would give overdevelopment. Within certain limits, these changes in the rate of development can be compensated for by increasing or decreasing the development time.

Besides these changes in development rate, there are other important effects dependent on the temperature. At high temperatures, the gelatin of the emulsion becomes so swollen and tender that it is easily damaged, and it may even loosen from the support, or wrinkle up in a fine network of lines, called "reticulation." The temperatures of the developer and other solutions must be kept sufficiently low to avoid danger of damage. When it is necessary to work at high temperatures, the special precautions described under "High-Temperature Processing," page 23, should be taken to prevent injurious effects on the film.

Agitation of the Developer. If exposed photographic materials are placed in a developer solution and allowed to develop without any movement, the action soon slows down because the developing power of the solution in the emulsion and in contact with its surface becomes exhausted. If the material is agitated, however, fresh portions of solution are continually being brought to the emulsion surface, and the rate of development remains constant. Therefore, agitation has an important effect on the degree of development obtained. An even more important effect of agitation is prevention of uneven development or mottle. If there is no agitation, the exhausted solution, loaded with halide from the emulsion, may flow slowly across the emulsion from the dense areas and produce uneven streaks. Agitation keeps the solution uniform throughout and avoids uneven development.

Since the degree of agitation affects the rate of development, the statement of a development time would mean little if the degree of agitation were not included. The development times mentioned in various places in this book, and in other Kodak publications, usually relate to one or the other of two general types of agitation, tank or tray, as described in the section on Processing Technique.

Activity of the Developer Solution. The rate of development is affected also by the chemical activity of the developing solution. This depends upon its composition and primarily upon the nature and concentration of the developing agent and the effective alkalinity of the solution. For example, Kodak Developer D-76 with its mild alkali, borax, has a slower rate of development than Kodak Developer DK-60a containing Kodalk Balanced Alkali; this, in turn, is slower than Kodak Developer D-11 which contains sodium carbonate. Also, the developer's activity is affected by any dilution of the solution.

In addition, the exhaustion of the developer affects the activity of the solution. When a developer is used, its developing power decreases, partly because of the destruction of the developing agent in changing the exposed silver halide to metallic silver, but primarily because of the restraining effect of the accumulated reaction products of the development. Even when the developer is not used, its activity may decrease because of aerial oxidation of the developing agent.

REPLENISHERS

With varying degrees of success, depending upon the nature of the developer, the decrease in developer activity with use can be partially overcome by increasing the development time. A better procedure, and one particularly valuable when large quantities of solution are involved, is to compensate for developer exhaustion by periodically adding small quantities of replenisher solution. Usually these replenishers are of such strength that, when used to replace the developer carried out by the film or paper, the developer activity is held approximately constant.

The quantity of developer solution carried out varies with the processing conditions. Most replenisher formulas are balanced to suit their major field of use; for other conditions, adjustments may be necessary. If, after replenishment, the developer has lower than normal activity, more replenisher should be added, even though it is necessary to discard some developer. If the developer tends to gain in strength from replenishment, dilute 2 parts of the replenisher with 1 part of water, and add this solution to maintain the volume constant.

Small volumes of developer are best replenished by the addition of a definite quantity of replenisher for each roll or sheet of film processed.

Ordinarily, constant developer activity will be maintained by adding 1 ounce of replenisher for each 80 square inches of film. This is equivalent to one 8 by 10-inch or four 4 by 5-inch sheet films, one 620 roll film, or one 36-exposure roll of 35mm film. After processing 1 roll of film, pour 1 ounce of replenisher solution into the empty developer storage bottle. Then pour enough used developer into the bottle to fill it to the original volume, discarding any excess. If short of the original volume, add unused developer solution or replenisher diluted 2 parts with 1 part of water to make up for the loss. Repeat for each roll developed.

It is impractical to exhaust and replenish a developer indefinitely because the solution accumulates a silver sludge as well as particles of dirt and gelatin which may adhere to the film surface. The developed films should be examined carefully and the developer discarded if it shows any indication of giving trouble such as stain or fog, or if the strength shows much tendency to vary.

STOP BATHS

The primary purpose of an acid rinse or stop bath between development and fixation is to check development instantly by neutralizing the developer carried over. An acid stop bath also minimizes the formation of dichroic fog; removes calcium scums which may have formed in the developer; and, by delivering the film into the fixing bath in an acid condition, preserves the acidity and hardening of that bath and tends to prevent the formation of alum scums and sludges. A hardening stop bath is desirable for films and plates in warm weather since it serves to prevent excess swelling.

The use of a stop bath is recommended particularly for paper prints, which often tend to stain when transferred directly from developer to fixing bath without thorough agitation in the fixing bath.

FIXING BATHS

In addition to the hypo which dissolves the undeveloped silver halides, most practical fixing baths contain an acid, such as acetic acid; a preservative, such as sodium sulfite; and a hardening agent, such as potassium alum. The alum is added to harden the gelatin of the emulsion in order to prevent excessive swelling or softening in the wash water, particularly under summer conditions. The acid serves to provide the best conditions for efficient hardening action, and the sodium sulfite is necessary to prevent the hypo from being decomposed by the acid.

If boric acid is added to a bath of this type, it increases the hardening power of the alum and also helps to prevent the formation of aluminum sulfite sludge which might be formed if the stop bath should fail to neutralize the developer carried over by the emulsion.

Time of Fixing. In use, the fixing bath should not only dissolve the silver halide grains, but also remove these dissolved silver salts from the emulsion. In fixing films and plates, a good rule is to let the bath act for twice the time it takes to clear the milky appearance in order to allow the silver salts to diffuse out of the emulsion. With paper prints, the clearing point is not visible, and the fixing time recommended for the paper should be used. Excessive fixing times should be avoided, as they prolong the washing time necessary to remove the hypo. The bath must fix the whole area of the emulsion, which it cannot do if several films or prints are piled together. They should be kept separated and the bath should be agitated.

As the bath is used, the silver compounds accumulate in the solution; the bath becomes slower in action and has more difficulty in removing the last trace of silver salt from the emulsion. If the bath is kept in use too long, past the point when it takes twice as long to fix as it did when fresh, it may lose its ability to remove all of the unused silver salts. Although not visible, these will remain in the emulsion even after washing, and, with age, will decompose and stain the negative or print.

In order to insure complete fixing, especially with paper prints, it is a good plan to use two baths, treating the sensitive material in the first until the emulsion has cleared, then transferring it to a second bath for an equal time. The first bath does most of the work, and the second bath removes the last traces of silver compounds. When the first bath approaches exhaustion, it is discarded and the second bath put in its place. A fresh fixer is then prepared and used for the second bath. In this manner, the second fixer is kept fresh and active.

Testing Stop Baths and Fixing Baths. Stop baths and fixing baths should not be used beyond exhaustion, as this leads to stains and spots on the negatives or prints which may be evident either immediately or not until some time later. An overworked stop bath will be neutralized by the developer solution carried over, so that it ceases to check development and becomes useless as a stop bath.

Except for baths which contain a special indicator dye, such as the Kodak Indicator Stop Bath, the appearance of stop baths and, to some extent, of fixing baths does not change until well beyond their useful lives. Some means of determining quickly and accurately when they are unsafe for further use should therefore be employed. The Kodak Testing Outfit for Print Stop Baths and Fixing Baths provides a positive method of testing the baths used for prints.

It is recommended that one fixing bath be used for films and plates and another for papers. If it is necessary to use the same bath for both, the test for fixing baths for papers should be used.

NECESSITY FOR WASHING

After all of the undeveloped silver halide has been removed, the emulsion is still saturated with the chemicals of the fixing bath and some dissolved silver compounds. If these were not removed by washing, they would slowly decompose and attack the image, causing it to become discolored and faded.

Time for Complete Washing. Only exact experimental measurements will tell how quickly a particular vessel and stream of water will wash a specific kind of paper or film. Complete washing is obtained in the minimum time when the surfaces of the material are exposed to a rapid flow of fresh water. The washing time is influenced by the nature and condition of the fixing bath, design of the washing vessel, and temperature of the wash water. The washing efficiency decreases rapidly with decreased temperature and is very low at temperatures below 60 F.

Hypo is generally eliminated from most negative materials in 20 to 30 minutes if the rate of flow of water is rapid enough to replace completely the water in the washing vessel once every 5 minutes. Paper prints should be washed at least 1 hour under these conditions to insure satisfactory freedom from hypo. The time is measured from the immersion of the last plate, film, or print in the washing vessel, since the partly washed emulsions will absorb hypo from contaminated water just as readily as they give it up to fresh water. Rinsing each film or print before placing it in the washing vessel will remove the excess hypo from the surfaces and thus materially aid the washing process.

Papers require a longer washing time than films because small quantities of hypo are held tenaciously by the paper base and are difficult to remove by washing alone. Kodak Hypo Clearing Agent is a washing aid which makes possible more rapid and complete washing of prints to produce greater stability than can be obtained under normal processing conditions. Treatment in Hypo Eliminator HE-1 is recommended for removing the last traces of residual hypo in photographic prints intended for archival record purposes.

Preparation of Solutions

WATER SUPPLY

Impurities in water supplies are not responsible for as many troubles as it is usually supposed. Although most tap water does contain a certain amount of suspended matter and dissolved salts and gases, most of these impurities have no photographic effect.

Large quantities of suspended organic matter, particles of finely divided sulfur which give the characteristic opalescence to sulfur waters, hydrogen sulfide, and soluble metallic sulfides are the only impurities likely to cause serious trouble with developers. If there is sufficient suspended matter to cause spots on negatives or prints, the water should be filtered. Organic matter is usually precipitated on mixing the developer, but, frequently, biological growths and bacteria thrive in a developer and form a slime or scum on the walls of the tank. Some types of these growths act on the sulfite in the developer and change it to sodium sulfide which fogs the emulsion. Organic matter may also give trouble in the washing process since it is likely to be coagulated by the alum introduced from the fixing bath and settle on the surfaces of the negatives or prints.

Sulfides can be removed from a developer by developing some waste film or by adding 25 grains of lead acetate per gallon (0.4 gram per liter) of developer. The precipitated lead sulfide and excess lead will settle and the clear liquid can be decanted for use.

Extremely hard water may give a finely divided precipitate when the developer is mixed. This precipitate will usually settle out on standing, but even if it remains in suspension, it will have no photographic effect. If the precipitate is considered objectionable, it can generally be avoided by the addition of Kodak Anti-Calcium.

Certain developers which are clear when mixed may form a finely divided precipitate after they have been used. This is a normal effect and is not an indication of poor mixing or impure water.

A chemical analysis of the water supply usually reveals very little concerning its photographic usefulness. The only really useful test is to prepare the required photographic solution with the suspected water sample and actually try it; then compare these results with those obtained with the same developer or fixing bath prepared with distilled water. In most cases both solutions will be alike in their photographic effect, even if not in appearance.

TYPES OF CONTAINERS

Glass, hard rubber, polyethylene, enameled steel, and stainless steel are the materials most commonly used in the construction of containers for mixing, storing, and using photographic solutions. All are used safely with any ordinary solution. The choice is determined primarily by economy, convenience, or size availability.*

Not all metals are suitable. Tin, copper, and their alloys may cause serious chemical fog or rapid oxidation when used with developers. Aluminum, zinc, or galvanized iron should not be used with either developers or fixing baths.

With any vessel, care should be taken to avoid inaccurate measurements of volume. It is common practice, when a bottle is used, to bring the solution to final volume by filling to the top or neck of the bottle. In many cases, so-called quart or gallon bottles may hold considerably more or less than the nominal volume and, unless calibrated, will cause errors in dilution.

CLEANLINESS

Contamination of solutions during mixing is a frequent cause of defective negatives and prints. All mixing apparatus should be cleaned thoroughly immediately after use to prevent the formation of incrustations which may dissolve when a new solution is mixed.

It is desirable to use a mixing vessel for only one type of solution. If several solutions are to be mixed, they should be prepared in the order in which they are used in processing. Traces of developer in a fixing bath will have little or no effect, but small quantities of hypo in a developer may cause serious fogging or image tone changes. If a solution is mixed directly in a processing tank, other tanks should be covered to prevent contamination by particles of chemicals.

MIXING SOLUTIONS

When solutions are made up, it is essential that the constituents be dissolved in the proper order to avoid undesirable reactions.

In order to avoid the possibility of error in mixing, most Kodak formulas are arranged so that the ingredients are named in the order in which they should be dissolved unless the directions specifically state otherwise.

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*For a comprehensive survey of the photographic suitability of a wide range of currently available materials, see "Materials of Construction for Photographic Processing Equipment," Crabtree and Muehler, *PSA Journal* (Phot. Sci. Tech.) *19B:* 79-88, No. 2, May 1953; 92-104, No. 3, August 1953. This information has been summarized and brought up to date in Kodak Pamphlet No. K-12, *Construction Materials for Photographic Processing Equipment.*

When solutions are made from packaged preparations, the instructions supplied with the package should be followed. With preparations supplied in powder form, the entire contents of a container should be used in making up a solution, and no attempt should be made to prepare a small quantity of solution by using only a portion of the chemicals. Otherwise, because of possible segregation of the granular constituents during shipping and handling, considerable difficulty may be encountered in obtaining solutions with uniform characteristics.

Temperature. Photographic solutions are usually prepared by dissolving the constituents in water at a specified temperature. Developers are mixed at 90 to 125 F (32 to 50 C), while with most packaged fixing baths the temperature should not exceed 80 F (27 C).

Agitation. Proper agitation when mixing is important, not only to increase the rate of solution of the chemicals, but also to avoid undesirable effects. A type of agitator which will not introduce excessive air into the solution should be used. Developers are particularly prone to oxidize readily; a few minutes of violent agitation may weaken the developer noticeably and produce staining compounds. On the other hand, insufficient agitation may permit the chemicals to settle and form a hard cake which will not dissolve readily.

Care should be taken to stir the solution thoroughly after the addition of the final volume of water. The concentrated solution at the bottom of the vessel is heavier than water and will tend to remain at the bottom if not thoroughly mixed.

Mechanical agitation is a convenient means of insuring proper mixing. Several types of electric mixers are available, including commercial models used in preparing large batches of chemicals. They should not operate at such high speeds as to induce frothing or aeration of the solution.

MEASUREMENT OF SMALL QUANTITIES

When quantities of chemicals under 10 grains, or 0.7 gram, are included in a formula, they are expressed preferably as a 10 percent solution to be added as so many drams or cc. If less than a dram is required, an even quarter-fraction thereof should be used. This plan avoids expressing the volume in "drops," a very uncertain quantity which varies as much as 150 percent, depending on the way it is measured and the specific gravity of the liquid used. The average drop from the usual dropping bottle or burette measures about one minim, or approximately one-twentieth of a cubic centimeter.

To obtain a 10 percent solution of a solid, dissolve 1 ounce of the solid in about 8 ounces of water, and add water as necessary to bring the total volume to 10 fluid ounces; or dissolve 10 grams of the solid to make 100 cc of the solution.

STORING SOLUTIONS

Most photographic solutions will remain in good condition for weeks or months if properly stored. In the studio or finishing plant, the solutions are usually kept in the processing tanks. The tanks, when not in use, should be protected with a floating cover to lessen the rate of aerial oxidation and to prevent contamination from dust and other foreign bodies. Kodapak Sheet formed into a shallow tray makes a satisfactory cover. The sides of the tray should be about 2 inches high and a trifle smaller than the tank, with a handle fastened at the center of the inside with Kodak Film Cement. Polyethylene sheeting will float on the developer solution and can also be employed conveniently.

Small quantities of solution are best kept in stoppered bottles. Screw tops are quite satisfactory provided that they are free from rust or other foreign materials, have liners or gaskets, and are screwed down tightly. However, improperly sealed screw-cap closures are probably a major cause of developer oxidation. Kodak chemical preparations in solution form are supplied in containers with tight-fitting tops individually molded to the bottles.

To avoid contamination, no one cork should be used for more than one type of solution. Glass stoppers have a tendency to stick, especially with alkaline solutions.

Air is one of the worst enemies of a photographic solution. Oxidation may take place even in a tightly sealed bottle if the solution level is low. When stock solution is used from a large bottle, the air space is increased each time the bottle is opened, and the chances for aerial oxidation are greatly increased. It is best, therefore, to store stock solutions in small bottles. A small air space should be left so that the solution volume, varying with temperature, will not loosen the stopper or burst the bottle. The entire contents of a small bottle can be used at one time, leaving the remaining bottles undisturbed.

The temperature of storage is important. Developers, in particular, oxidize rapidly at elevated temperatures, with a resultant loss in activity and an increased propensity for staining. A developer which normally keeps for 2 or 3 months at 65 to 70 F may be unsatisfactory in a few days at 90 or 95 F.

Storage at too low a temperature can also be undesirable. Some concentrated solutions crystallize readily at low temperatures (usually, below 55 F) and redissolve with great difficulty or not at all, even when heated. Repeated changes in temperature may shorten the life of many photographic solutions.

CLEANING PROCESSING APPARATUS

Trays, tanks, and other processing equipment sometimes become discolored or coated with decomposition products of the photographic solutions. While this may do no harm if a container is always used for the same kind of solution, it is much better to clean all containers each time they are emptied. The simplest method of cleaning a tray or tank is to wash it out several times with water and then wipe the surfaces with a clean cloth. This procedure is preferable to the constant use of strong cleaning solutions which should be used only when washing is ineffective. Most cleaning solutions are either strong alkalies or acids and should be used with discretion.

Trays and Tanks. Stains from oxidized developer are usually of brown or yellow-brown color. Fresh stains can often be removed by washing with soap and water and wiping with a cloth. Severe stains require the use of a strong oxidizing solution, such as Kodak Tray Cleaner TC-1 or TC-3. These cleaners will also remove most deposits of silver or silver sulfide.

Developer tanks often become coated with a scale consisting essentially of basic calcium sulfite which is difficult to remove by scrubbing. This scale is soluble in acids, but the ease of removal varies according to the conditions under which the scale was formed. As a first trial, the tank should be filled with Kodak Stop Bath SB-1 and allowed to stand overnight. If this does not loosen the scale sufficiently, a five percent solution of acetic acid should be tried or, better, a five to ten percent solution of citric acid. The latter should be used with care, particularly with stainless steel, on which it is apt to cause serious pitting. The tendency for formation of such scale can be greatly reduced by the use of Kodak Anti-Calcium in the developer.

Large developer tanks of wood or stoneware often become coated with a layer of slime consisting of gelatin, organic matter, fungus and mold growths, and dust. Some of the molds or fungi can act on the sulfite of the developer and convert it to sodium sulfide, which is a strong fogging agent. Trouble from this source can be avoided by sterilizing the tank at regular intervals, especially during warm weather. The tank should be scrubbed thoroughly with a wire brush, then filled with a solution of sodium hypochlorite and allowed to stand overnight. It should then be emptied and given another thorough scrubbing and five or six washings with plain water before being used again. Bleach solutions sold for laundry use usually consist of sodium hypochlorite, or a solution can be prepared by adding sodium carbonate solution to a solution of calcium hypochlorite (bleaching powder) until no more precipitate is formed.

Film Hangers and Clips. Metal film hangers and clips tend to accumulate a plating of silver when immersed in a fixing bath which contains dissolved silver salts. Such deposits are often of a spongy nature and may be mixed with gelatin and other substances. These deposits absorb chemicals from the processing solutions and are not removed by ordinary washing; then, when the hangers are reimmersed in the developer, some of these chemicals may leach out and cause either light or dark streaks on the film.

There are several methods of removing such deposits, and the choice of method will depend on the severity of the conditions. The acetic acid treatment described below is the simplest; boiling with trisodium phosphate, however, will be more effective in most cases. Tray cleaner should be used with caution on metal equipment.

Acetic Acid Treatment: Soak the hangers or clips for an hour in a tray or tank filled with 10 percent acetic acid solution (1 part glacial acetic acid to 9 parts of water). The acid tends to loosen the deposit. Then wash with clear water and scrub off the deposit with a stiff brush.

Trisodium Phosphate Treatment: Boil the equipment for several minutes in a 10 percent solution of trisodium phosphate; then wash it with water and scrub thoroughly with a stiff brush. This method is especially useful for cleaning deposits of spongy silver mixed with gelatin. Do not use it for aluminum ware.

Acid Dichromate Treatment: If the silver deposit clings tenaciously to the metal hangers, it may be necessary to dissolve it with Kodak Tray Cleaner TC-1 diluted 1 part TC-1 to 2 parts of water.

The length of time the hangers or clips should remain in this solution depends on the quantity of silver to be removed. An immersion of 10 minutes is usually sufficient. When the articles are removed, rinse them thoroughly and brush off any reddish-colored scale. It is advisable to use a glass or hard-rubber tray since an enamelled tray will be etched slowly by the cleaning solution. This solution should not be used with chromium-plated metal articles because it tends to destroy the copper undercoating.

Sandblasting: Heavy deposits are best removed by sandblasting.

Processing Technique

PROCESSING OF FILMS AND PLATES

Tank development with intermittent agitation is highly recommended for roll films, film packs, sheet films, and plates. The use of a tank enables the operator to produce clean, evenly developed negatives, and at the same time permits more accurate control of development factors than is possible in any other way. Tank development is the most practical method of processing 35mm films.

After use in a small tank, a developer solution can be poured into a bottle for storage, while larger tanks are usually left filled, preferably with a floating cover to protect the developer from aerial oxidation. Solutions used in a tray should be discarded after one use.

In the development of films and plates, certain methods of agitation must be followed to insure uniform development and freedom from flow marks. Development irregularities due to improper agitation are a principal cause of many poor-quality negatives. Such effects as edge intensification, streaks, irregular densities, and mottle are caused by insufficient or excessive agitation, but can be avoided by following the various recommended procedures.

When films or plates receive little or no agitation, or are allowed to remain undisturbed too long between periods of agitation, the accumulation of development by-products is not replaced adequately by fresh developer solution, and uneven development results. With excessive agitation, intensified edge development may occur because of the greater turbulence of developer around the edges of the film or plate, or through the perforations of developing hangers.

The several procedures described in the following pages are recommended to produce uniform, high-quality results. These instructions assume correct use of the recommended safelight.

Small-Tank Development: Roll Films, Film Packs, and Small Sizes of Sheet Film (in Tanks with Removable Reels or Racks). Fill the tank with developer at the proper temperature, 68 F (20 C); turn out the light; load the film on the reel; and proceed as follows:

1. Start the timer. Place the loaded reel in the tank containing the developer. Keep the reel under the surface of the solution, and tap it gently on the bottom of the tank to aid in dislodging air bells before you replace the cover on the tank. After the cover has been replaced, developing and other operations can be done in full room light.

2. For tanks that cannot be inverted: After the reel has been immersed 30 seconds, agitate the tank for 5 seconds by sliding it back and forth over a distance of about 10 inches at a rate of 2 cycles per second. At the same time, turn or rotate it back and forth through about one-half turn. Repeat the agitation at intervals of 30 seconds.

With tanks permitting an inversion type of agitation: After the reel has been immersed 30 seconds, invert the tank once per second for 5 seconds. Repeat at 30-second intervals throughout the total developing time.

3. Pour out the developer and fill the tank with Kodak Indicator Stop Bath or Kodak Stop Bath SB-5, at 65 to 75 F (18 to 24 C). Agitate continuously for about 30 seconds. For a water rinse, empty and refill the tank several times with fresh water.

4. Pour the fixing bath into the tank and agitate the tank as above for about 30 seconds. Repeat several times during fixing.

5. When fixing is complete, wash the negatives for 30 minutes in running water. This can be done in the uncovered tank. Empty the tank at 5-minute intervals to obtain more thorough washing.

Tank Development: Sheet Films and Plates in Hangers. No more films or plates should be developed than can be accommodated with at least a half-inch separation between the hangers. It is important to maintain this separation when the hangers are lifted for agitation, by some means such as the use of a suitable developing hanger rack. Arrange the tank so that the plane of the films will be parallel to the front edge of the bench or sink. With the processing solutions at a temperature of 68 F (20 C), turn out the light, load and assemble the developing hangers, and proceed as follows:

1. Start the timer. Lower the hangers as a unit smoothly and carefully into the developer. Immediately tap the hangers sharply two or three times on the upper edge of the tank to dislodge any air bells clinging to the emulsion. Check the spacing of the hangers to make certain that they are at least one-half inch apart.

2. Allow the hangers to remain undisturbed for the remainder of the first minute. Then, quickly but smoothly, lift them clear of the solution and, keeping the plane of the films parallel to the edge of the bench or sink, rotate them one quarter turn either clockwise or counterclockwise, and back. Immediately reimmerse them and again lift them clear of the solution, rotating them one quarter turn in the opposite direction. It is important that the angle of rotation should not be appreciably less than 90 degrees. Reimmerse the hangers quickly in the solution and check their spacing as in paragraph 1.

The entire cycle of lifting and reimmersion should be as rapid as possible without interfering with smooth operation. It should be completed in about 5 to 7 seconds. Repeat at one-minute intervals. *Caution:* With films larger than 5 by 7 inches, take care not to lift or immerse them so quickly that the films are pulled from the hangers.

3. When development is complete, lift the hangers from the developer, drain them for 1 or 2 seconds, and transfer them to the stop bath or rinse water. Lift and reimmerse the hangers several times before transferring them to the fixing bath.

4. Lift and reimmerse the hangers several times at the beginning of fixing and again at the end of the first minute. Allow them to remain until fixing is complete. Separation of the hangers and frequent agitation will shorten fixing time.

Tray Development: Roll Films. With the solutions at the proper temperature, follow these steps:

1. Unroll the paper backing and fasten a film clip to the end of the film. Place the clip over a hook on the wall (about 6 feet above the floor) and slowly unwind the remainder of the film, maintaining a slight tension to prevent coiling. Detach the film at its lower end from the protective paper backing and attach a second film clip.

2. Remove the clip from the hook and, with one clip held in each hand, allow the film to sag in a U loop with the emulsion side down. Pass the film through water at 65 to 70 F (18 to 21 C) by alternately lowering one end while raising the other at the rate of once every 5 seconds for about 1 minute. This pre-wetting helps to prevent the formation of air bells and greatly reduces the tendency to curl.

3. Start the timer. Turn the film so that its emulsion side is up and transfer it promptly to the developer. Proceed in the manner described above, and continue the movement throughout development.

4. Pass the film up and down through the rinse water or stop bath 2 or 3 times.

5. Transfer the film to the fixing bath contained in a deep tray and continue agitating for 2 minutes. Then place one end of the film, emulsion side up, in the fixing tray and lower the strip in folds into the solution. For shallow trays or long rolls, it may be desirable to cut the negatives into 2 or 3 lengths to avoid the necessity for looping in the tray. Move the films at intervals to insure uniform fixing.

6. When fixing is complete, place the films in a deep washing tray and wash thoroughly in running water for 20 to 30 minutes.

Tray Development: Single Sheet Film or Plate. Tray development of a single film or plate can be accomplished best by placing about ½ inch of developer in a tray somewhat larger than the film. With the solutions at the proper temperature, proceed as follows:

1. Start the timer and immediately slide the film or plate, emulsion side up, smoothly into the developer. Agitate the tray continuously throughout development as follows:

Raise the left side of the tray about ½ to ¾-inch; lower it smoothly, and then immediately raise and lower the near side similarly; next, raise and lower the right side, and then again the near side. These four operations constitute an "agitation cycle," which requires a total time of about 8 seconds.

2. When development is complete, rinse the negative in a separate tray with agitation for several seconds in fresh water or a stop bath.

3. Transfer the film or plate to the fixing bath and agitate by rocking the tray as described above for about 30 seconds. Repeat the agitation at intervals for the duration of the fixing time.

4. Wash the negative in running water for 20 to 30 minutes.

Tray Development: Several Sheet Films. The following method of developing 2 to 6 films in a tray is capable of producing good negative uniformity. However, considerable care is required to prevent digs or finger marks. Also, the temperature of the developer should not exceed 68 F (20 C) and the use of a highly alkaline developer should be avoided to prevent softening the gelatin. A modification of this procedure is recommended for tray development of color-separation negatives.

Using trays slightly larger than the films and with the solutions at the proper temperature, follow these steps:

1. Immerse the exposed films one at a time and emulsion side up in a tray of water, at not above 70 F (21 C). The topmost film must be completely covered with water before the next film is placed over it. When all the films are in the tray, draw one film carefully from the bottom and place it on top. Handle the film only by the extreme edges, and take care to prevent a corner of the film from digging into the emulsion of the film on the top of the pile. Repeat this replacement from bottom to top until the films have been leafed through twice. This pre-wetting procedure will prevent films from sticking together and also dislodge any air bells which may have formed.

2. Start the timer and transfer the films quickly, one at a time, from the bottom of the pile into the developer tray. Continue the rotation of films from bottom to top throughout the period of development. At intervals, turn the films end for end, emulsion side up, as they are placed on the top of the pile.

3. When development is complete, transfer the films, one at a time, to the Kodak Stop Bath SB-5, and leaf through the pile twice. Contamination of the developer with the stop bath can be avoided by using one hand for removing the films from the developer and the other hand for immersing them in the stop bath.

4. Place the films, one at a time, in the fixing bath. Continue the replacement from bottom to top 2 or 3 times immediately and then at intervals until the negatives are completely fixed.

5. Wash the negatives in running water for 20 to 30 minutes by continuing the rotational method or by placing the negatives in developing hangers and using a washing tank.

Tray Development: Several Plates. If several plates are to be developed in a tray, the tray should be large enough to hold all the plates in separate positions. Enough developer should be provided to cover the plates at all times as the tray is rocked. Overlapping of the plates during development and fixing can be avoided by the use of rubber suction cups, which are attached to the bottom of the tray in such positions as to keep the plates separate when the tray is rocked.

With the solutions at the proper temperature, follow these steps:

1. Start the timer. Then, handling each plate individually and by the edges, slide the plate (emulsion side up) under the developer and into its proper position in such a manner that the entire emulsion surface is wetted almost instantly. Note the position of the plates so that they can be removed in the same order as they are immersed. With a large wad of cotton which has been previously soaked in the developer, swab lightly over the entire surface of each plate in order to remove any air bells which may adhere to the emulsion.

2. Agitate the tray continuously throughout development as follows: Raise the left side of the tray ½ to ¾-inch; lower it smoothly and then immediately raise and lower the near side similarly; next, raise and lower the right side, and then again the near side. These four operations constitute an "agitation cycle" which requires a total of about 8 seconds. Do not allow any of the plates to become partially uncovered by developer.

3. At the end of the development time, take the plates from the developer in the same order as they were immersed and rinse them quickly in the water rinse or stop bath. Then place them in the fixing bath. Contamination of the developer with the fixing bath can be avoided by using one hand for removing the plates to the rinse or stop bath and the other hand for immersing them in the fixing bath.

4. After fixing, wash in running water for 20 to 30 minutes.

DRYING FILMS AND PLATES

After washing, grit and scum should be swabbed from the emulsion with a tuft of cotton applied under water. As soon as the film or plates are taken from the wash water for drying, water droplets should be removed with a damp Kodak Photo Chamois or soft viscose sponge, or the negatives can be bathed in diluted Kodak Photo-Flo Solution for about 30 seconds and drained before drying. The negatives preferably should be removed from the channel-type hanger before drying.

Drying should be done in a warm, dry room free from dust and excessive drafts, or in a cabinet supplied with warm, filtered air.

DEVELOPMENT TIMES

Development recommendations for various Kodak films and plates are given in the tables on pages 32 and 33.

The development times shown will usually produce a degree of development suitable for the types of work for which each material is most generally used. Thus, the times recommended for portrait films give a slightly lower degree of development than those for press films. Longer or shorter times can be used if experience indicates that an increase or decrease in the degree of development would be desirable for the particular working conditions and the type of camera and printing equipment in use.

The times given in connection with each developer formula, and on the labels of packaged developers, are of necessity average times which give good results with most materials; naturally, they cannot agree exactly with the different times which are recommended specifically for each individual material.

The recommended development times are usually given for 68 F (20 C). Whenever it is necessary to work at some other temperature the development time should be adjusted, to compensate for the difference in the rate of development. The time adjustment required at various temperatures is indicated for a number of developers in the Time-Temperature Development Charts on page 24. For best results the developer temperature should be kept between 65 and 70 F.

The Developing Computer in the Kodak Master Darkroom Dataguide provides a convenient means for determining the development times to produce approximately equal degrees of development with a large number of combinations of Kodak films and developers. It also provides a very convenient means for adjusting the times if a higher or lower degree of development is desired.

RAPID FILM PROCESSING

In some situations, such as in newspaper work, it is occasionally necessary to process a negative as quickly as possible. The processing time can be shortened considerably over normal processing times by the use of a fast-working developer, such as Kodak D-19, Kodak Dektol, or Kodak D-72, and by taking certain short cuts in fixing and washing.

For rapid processing and where permanence of the image is not important, fixation can be considered adequate as soon as the milky appearance has cleared from the emulsion. The use of a fresh fixing bath and thorough agitation of the film in the fixing bath decreases the clearing time considerably and helps to produce adequate hardening of the emulsion. For most rapid fixing Kodak Rapid Fixer (with Hardener) is recommended. This is supplied as a concentrated fixer solution, with the hardener solution in a separate bottle. When mixed according to the instructions given for rapid fixing, the fixing rate is more than twice as fast as with usual fixing baths, such as Kodak F-5, and the useful capacity is considerably greater.

The processing is completed by washing the film a few minutes in a rapid stream of water and drying with currents of warm air directed against both sides of the film.

To hasten the drying and prevent the formation of water marks on the film, all drops of surface water should be removed by wiping both sides of the film with a Kodak Photo Chamois or soft viscose sponge. Rapid drying can also be obtained by (1) treating the film in a saturated solution of potassium carbonate, which removes the water from the emulsion and leaves the film dry enough for printing, or (2) soaking the film in alcohol for a minute or so before drying it. Methyl alcohol should not be used since it attacks the film base. Ethyl or isopropyl alcohol can be used successfully provided that the alcohol is diluted with 10 percent of water, the film is not bathed in the alcohol for too long a period, and the film is finally dried with air at a temperature not higher than 70 to 80 F (21 to 27 C). Soaking the film in undiluted alcohol and drying with air which is too hot may cause the gelatin to become opalescent. If this should occur, the opalescence can usually be removed by soaking the film in water and drying slowly.

After the rush prints have been made, the negatives should be returned to the fixing bath for 5 or 10 minutes and then washed thoroughly and dried in the usual manner to prevent fading or staining.

HIGH-TEMPERATURE PROCESSING

Whenever possible, the temperature of the processing solutions should be held at 65 to 70 F. When this is not practical, special precautions must be taken to avoid excessive swelling and softening.

Most developers, except highly alkaline solutions, can be used up to 75 F (24 C), provided that the development times are properly shortened and effective hardening rinse and fixing baths are used.

At higher temperatures, the use of Kodak Prehardener SH-5 before development will harden the emulsion sufficiently to allow use of normal solutions and processing procedure, even at temperatures as high as 110 F (43 C). Full instructions for use, including adjustment of developing time for various temperatures, are given with the prehardener formula in the Formulas section.

The use of the prehardener is the simplest and safest procedure for processing at high temperatures. When the prehardener is not available, however, the addition of sodium sulfate to the developer solution will permit operation at temperatures up to 90 or 95 F (32 to 35 C). Addition of the quantities of sodium sulfate shown in the table below will maintain approximately normal developing times at the higher temperatures. When using any of these developers, it is necessary to observe the following precautions:

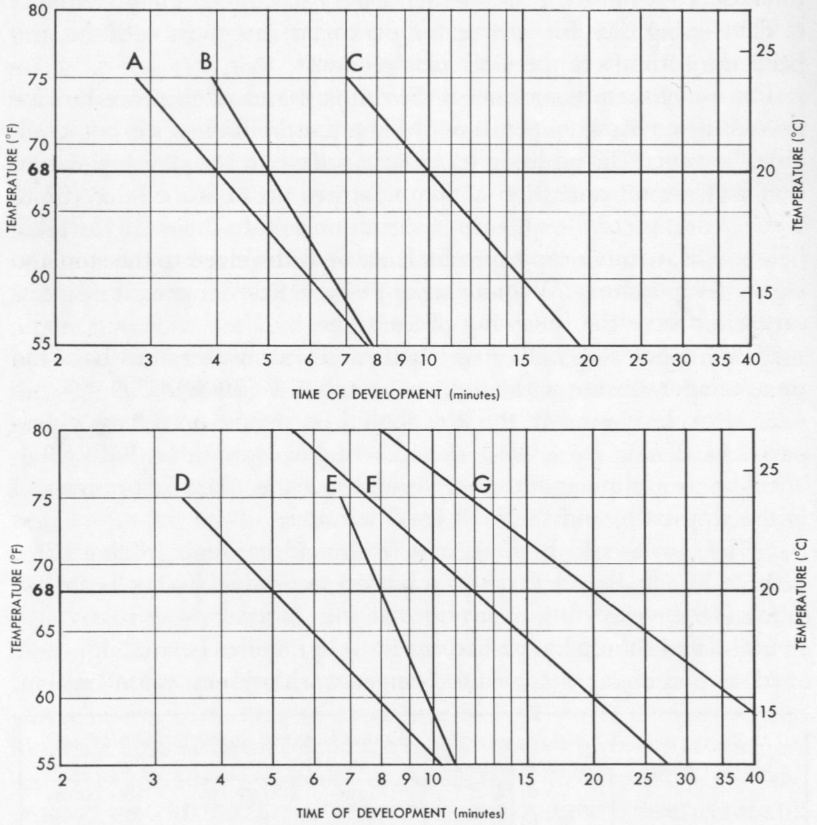
1. Developer, stop bath, fixing bath, and wash water must be at the same temperature to within approximately 5 F (2.5 C).
2. After development, the film should be treated in a freshly prepared hardening rinse bath, such as Kodak Hardening Bath SB-4. The film should be agitated for several seconds when first immersed in the stop bath, and then left for 3 minutes.
3. The film should be fixed in a fresh acid hardening fixing bath, such as Kodak Rapid Fixer (2 minutes) or Kodak Fixing Bath F-5 (5 minutes).
4. The film should be washed for 10 to 15 minutes in running water or in several changes of water. Longer washing may cause trouble.

KODAK DEVELOPERS	RANGE OF TEMPERATURES	KODAK SODIUM SULFATE *(Desiccated)*	
		PER QUART	PER LITER
D-11 D-19 D-61a D-76	75 to 80 F	1 ounce 290 grains	50 grams
	80 to 85 F	2½ ounces	75 grams
	85 to 90 F*	3 ounces 145 grains	100 grams
DK-50 DK-60a D-72 (1:1) Dektol (1:1)	75 to 80 F	3 ounces 145 grains	100 grams
	80 to 85 F	4 ounces 75 grains	125 grams
	85 to 90 F*	5 ounces	150 grams

*If necessary to develop at 90 to 95 F, decrease the time about one-third.

TIME-TEMPERATURE DEVELOPMENT CHARTS

When the developing time required to produce the desired contrast at 68 F (20 C) is known, these charts can show the proper time to produce approximately the same contrast at other temperatures. Through the point for the correct developing time at 68 F, draw a line parallel to the heavy line representing the developer. Then the required developing time will be found directly below the point where this new line cuts the line for the temperature to be used. The lines in these charts show the slope of the time-temperature relations, but do not necessarily indicate recommended development times.



A—D-11
D-61a (1:1) (1:3)
D-72 (1:1) (1:2)
Dektol (1:1)
Versatol (1:3) (1:15)
Universal M-Q, 32 oz.

B—D-11 (1:1)
D-19
DK-50

C—DK-20
D-76 (also 1:1)
Microdol

D—DK-60a

E—DK-50 (1:1)

F—D-23

G—D-25

PROCESSING OF PAPERS

Correct processing of papers is vital to print quality and is best secured by following the manufacturer's recommendations. Excellent prints are possible only when the printing exposure is such that the desired print density is obtained in approximately the recommended development time. A common cause of "muddy" prints is underdevelopment. There is a natural tendency to pull out a rapidly darkening print before development is completed, but the resultant image is poor in tone and often mottled from uneven development. Overdevelopment or long treatment in an overworked solution is likely to cause a yellow stain due to developer oxidation products.

The developing tray should be somewhat larger than the largest print. This allows proper agitation and convenience in handling the prints. The exposed print is slipped edgewise and face up into the developer solution so that it is covered quickly and evenly. During development, the solution should be agitated by rocking the tray or by keeping the prints in motion. The prints should be kept completely immersed.

After development, the prints should be transferred to the stop and fixing bath quickly, without any intermediate examination. The prints should be immersed for 5 to 10 seconds in an acid stop bath, such as Kodak Indicator Stop Bath or Kodak Stop Bath SB-1, and then fixed for 5 to 10 minutes in a suitable acid hardening fixing bath, such as Kodak Photofix, Kodak Acid Fixer, or Kodak Fixing Bath F-5 or F-6.

By far the best practice is to use two fixing baths in succession. With both baths at 65 to 70 F (18 to 21 C), the prints should be fixed for 3 to 5 minutes in the first bath, drained for about 5 seconds, then fixed 3 to 5 minutes in the second bath. The prints should be agitated in the baths frequently to insure that the solutions have free access to all parts of the print surfaces.

After two hundred 8 by 10-inch prints, or their equivalent in area, per gallon of first bath have been fixed, discard the first bath. Advance the second bath to replace the first, and prepare a new second bath. An additional two hundred 8 by 10-inch prints per gallon of first bath can then be processed through these two baths. The system can be recycled for a maximum of five times before discarding both baths.

Prolonged fixing should be avoided, particularly with warm-tone prints, because of the tendency to bleach the image and change its tone and to increase the difficulty of thorough washing. Rapid fixing baths are inclined to attack the image if the fixing time is prolonged.

The prints must be washed for at least one hour, with a flow of water sufficient to change the water in the tray 10 to 12 times an hour. The tray should not be overloaded so that the prints mat together and can not be kept moving. The Kodak Automatic Tray Siphon is a convenient device for providing efficient circulation.

For most efficient washing, the water should be at a temperature of 65 to 70 F (18 to 21 C). If the water is colder than 65 F, longer washing times are needed, and with very cold water it is difficult to obtain adequate removal of hypo, even with long washing times. Water temperatures higher than 70 F are not desirable, because there is a tendency to soften and swell the emulsion, and the time required for thorough washing is not reduced appreciably.

The rate of removal of hypo can be speeded up, thereby reducing the washing time required, by the use of various washing aids. Kodak Hypo Clearing Agent is a very effective washing aid which promotes faster and more complete washing of prints without causing any swelling or softening of the emulsion that might lead to difficulties in drying or ferrotyping. When it is used, a 10-minute wash for single-weight prints or a 20-minute wash for double-weight prints is adequate, even with water as cold as 35 F, and at 65 to 70 F is more effective than a full hour of washing alone. For archival permanence, the Hypo Eliminator HE-1 is recommended for removing the last traces of residual hypo from the prints.

To protect against fading of prints exposed to oxidizing atmospheres, Kodak Rapid Selenium Toner can be added to the Kodak Hypo Clearing Agent solution, as described in its instructions. Prints treated in the Hypo Eliminator HE-1 can be similarly protected with Kodak Gold Protective Solution GP-1, following the Hypo Eliminator treatment.

After thorough washing, the prints should be placed on a clean glass or board and the excess water swabbed off with cotton or a viscose sponge. Glossy paper should be dried on ferrotype tins or drums when high gloss is desired. Prints which do not require ferrotyping can be dried in the Kodak Photo Blotter Roll, between sheets of Kodak Blotting Paper, or on clean cheesecloth stretchers. Ordinary blotters are too soft and linty and may contain impurities.

If prints curl after drying, they can be flattened by dampening their backs with water and re-drying between blotters under heavy pressure for two or three hours. Kodak Print Flattening Solution can be used to minimize curling of the prints.

TONING

The silver image produced by development is normally black or gray. The size and condition of the silver particles composing the image can be modified within certain limits by changes in the developer to produce tones ranging from blue-black to brown-black or olive-green. The range of tones which can be obtained by such variations in development is not very great, however, and, in order to produce more pronounced tones, the image must be changed by some chemical means. In most of the popular toning treatments, the silver image is converted to or covered by other metals or inorganic compounds such as silver sulfide.

Preparation for Toning. The color of a toned print is influenced by many factors, including variations in development, fixing, and washing, and the choice of paper type, grade, surface, and stock tint. The visual contrast and density are often changed, too. To assure the best possible quality, all of these factors must be considered and, where necessary, adjusted prior to toning.

Poor quality cannot be disguised by toning. A full scale of values, with sufficient detail in the highlights and shadows, is necessary. Prints to be toned in Kodak Sepia Toner or in Kodak Sulfide Sepia Toner T-7a should receive from 15 to 20 percent more than normal exposure. Those to be toned in Kodak Hypo Alum Sepia Toner T-1a should be given about 25 percent more exposure than normal, and those to be toned in Kodak Brown Toner or in Kodak Polysulfide Toner T-8 should be given an exposure of 10 to 15 percent above normal. Kodak Blue and Rapid Selenium Toners intensify the image slightly. Ordinarily, no change in exposure is required, but low-key prints may be improved by slightly less exposure.

The usual control manipulations, such as dodging, flashing, and over-all reduction of the print, if required, must be performed prior to toning. Prints which have been reduced must be washed well before toning, if pink stains are to be avoided. Residual silver salts and hypo retained in the paper may cause uneven toning or staining. For thorough washing, the prints should be rinsed in water after they have been fixed, and then treated in Kodak Hypo Clearing Agent as described on the preceding page.

It is important that no metallic surface come in contact with toning solutions. Enameled trays with no cracks or chipped spots are the most commonly used containers. Good enamel is as satisfactory as glass and far more practical. Wooden or stoneware tanks with hard-rubber faucets should be used for large-scale work.

Paper Characteristics. Not all papers tone alike. To accommodate the many negative ranges and to satisfy the personal tastes of photographers and the numerous applications to which photographic prints are put, a variety of paper emulsions must be made. These necessary variations in contrast, speed, and image tone affect the toning rate and final color. A series of illustrations showing the appearance of the tones obtained with various combinations of papers and toners is reproduced in the section on toning in the Kodak Data Book *Professional Printing with Kodak Photographic Papers.*

Because of individual preferences, it is not easy to recommend specific tones which will be considered pleasing by all observers. In the chart following, the Kodak toners, checked as recommended for use with the various Kodak papers, are ones which will produce tones acceptable to most people. Since the tones vary considerably in both color and strength, some experimentation is necessary to determine the one best suited to a particular use. The toners checked as not recommended produce either no change in tone or a very slight change toward an unpleasant tone.

The toners which are not checked will produce tone changes which, while not considered generally desirable, may have some application for special purposes.

RECOMMENDATIONS FOR USE OF KODAK TONERS WITH KODAK PHOTOGRAPHIC PAPERS

Kodak Paper	Kodak Toner						
	Rapid Selenium	Brown or T-8	Combined Brown and Selenium	Sepia or T-7a	T-1a	T-21	Blue
Azo		x	x			NR	NR
Ad-Type		x	x			NR	NR
Aristo	x		x			x	
Athena	x		x			x	
Ektalure	x		x			x	
Illustrators' Azo	x		x			x	
Illustrators' Special	x		x			x	
Kodabromide	NR	NR	NR	x		NR	NR
Medalist		x	x	x	x	NR	
Mural		x	x	x	x	NR	
Opal	x		x			x	
Panalure		x					
Polycontrast		x		x	x	NR	x
Polycontrast Rapid		x		x	x	NR	x
Portrait Proof	x		x			x	
Translite Enlarging	x		x			x	
Velox	NR		NR	x		NR	
Velox Premier	NR		NR			NR	
Velox Rapid	NR		NR	x	x	NR	
Velox Unicontrast			NR	x	x	NR	

x—Primary recommendation
NR—Not recommended

Page

Table—Keeping Properties and Capacities of Solutions 31
Table—Development Recommendations 32-33

Kodak Developers

Microdol, Dektol, Selectol 35
Selectol Soft, Ektonol, Duomat, Versatol, Universal M-Q 36
Tri-Chem Pack, D-8, D-11 37
D-19, D-19R, DK-20 38
DK-20R, D-23, D-25, DK-25R 39
DK-50, DK-50R, D-52 40
DK-60a, DK-60aTR, D-61a 41
D-61R, D-72, D-76 42
D-76R, DK-93 43

Kodak Stop and Hardening Baths

Indicator Stop Bath, Universal Stop Bath, Liquid Hardener, SB-1, SB-1a 44
SB-4, SB-5, SH-1 45
SH-5 46

Kodak Fixing Baths

Kodak Acid Fixer, Kodafix Solution, Kodak Rapid Fixer (with Hardener), Photo-Fix 47
F-5, F-5a, F-6 48
F-7, F-9, F-24 49
Processing For Permanence 50
Hypo Clearing Agent, Hypo Eliminator HE-1, Gold Protective Solution GP-1 50

Kodak Intensifiers and Reducers

In-1, Chromium Intensifier 53
In-4, In-5 54
In-6 55
Farmer's Reducer, Ammonium Thiosulfate Reducer 56
R-2, R-4a 57
R-4b, R-5, R-8a 58
R-15 59
Kodak Tray Cleaners—Stain Removers 60

Kodak Toners

Rapid Selenium Toner, Brown Toner 62
Sepia Toner, Blue Toner, T-1a 63
T-7a, T-8 64
T-21 65
T-12 66
Table—Use of Safelights 66

Kodak Chemical Processing Aids

Anti-Calcium, Anti-Fog No. 1, Anti-Fog No. 2, Anti-Foam 67
Testing Outfit for Print Stop Baths and Fixing Baths, Desensitizer, Photo-Flo Solution, Print Flattening Solution 68
Table—Weights and Measures Inside Back Cover

KEEPING PROPERTIES AND USEFUL CAPACITIES OF SOLUTIONS

The figures given in this table are estimates based on experience and are intended for use only as a guide. The values for keeping properties without use are for 65 to 70 F (18 to 21 C) and are proportionately less at higher temperatures. The useful capacity figures are based on exhaustion of the solution without replenishment. Under most conditions longer life and greater capacity can be assumed if some change in quality is tolerable.

SOLUTION	KEEPING PROPERTIES WITHOUT USE				USEFUL CAPACITY	
	STOCK SOLUTION STOPPERED BOTTLE		WORKING SOLUTION		8 x 10-INCH SHEETS PER GAL	
Film and Plate Developers	FULL	HALF FULL	TRAY	GALLON TANK	TRAY	NARROW AND DEEP TANK
Kodak D-8	2 Mo	2 Wk	2 Hr (2:1)	N. R.	15 (2:1)	N.R.
Kodak D-11	6 Mo	1 Mo	24 Hr	1 Mo	30	40
Kodak D-19	6 Mo	2 Mo	24 Hr	1 Mo	45	60*
Kodak DK-20	6 Mo	2 Mo	24 Hr	1 Mo	20	30*†
D-23	6 Mo	2 Mo	24 Hr	1 Mo	20	20
D-25	6 Mo	2 Mo	24 Hr	1 Mo	20	20
Kodak DK-50	6 Mo	2 Mo	24 Hr	1 Mo	20	40*
Kodak DK-60a	6 Mo	2 Mo	24 Hr	1½ Mo	20	40*
Kodak D-61a	6 Mo	2 Mo	24 Hr (1:1)	2 Wk (1:3)	15 (1:1)	30 (1:3)
Kodak D-72	6 Mo	2 Mo	24 Hr (1:1)	2 Wk (1:1)	30 (1:1)	40 (1:1)
Kodak D-76	6 Mo	2 Mo	24 Hr	1 Mo	10	10*†
Kodak DK-93	6 Mo	2 Mo	24 Hr	1 Mo	20	40
Microdol	6 Mo	2 Mo	24 Hr	1 Mo	16	16*†
Dektol	6 Mo	2 Mo	24 Hr (1:1)	1 Mo (1:1)	30 (1:1)	40 (1:1)
Versatol	I.O.P.	3 Mo	24 Hr (1:3)	2 Wk (1:7)	20 (1:3)	15 (1:7)
Kodak Universal M-Q	(Not intended to be replenished or stored.)				2 per packet	2 per packet
Paper Developers						
Kodak D-52	3 Mo	1 Mo			80 (1:1)	
Kodak D-72	6 Mo	2 Mo			100 (1:2)	
Kodak DK-93	6 Mo	2 Mo			80	
Versatol	I.O.P.	3 Mo	1 working day		80 (1:3)	
Dektol	6 Mo	2 Mo			120 (1:2)	
Selectol	4 Mo	6 Wk			80 (1:1)	
Selectol-Soft	4 Mo	6 Wk			80 (1:1)	
Ektonol	4 Mo	6 Wk			80 (1:1)	
Kodak Universal M-Q	(Not intended to be replenished or stored.)				50 prints, 2¼ x 3¼ inches, per packet	

*Life extended by addition of the proper replenisher.

†When the development time is increased about 15 percent after each 4 sheets per gallon.

I.O.P.—Indefinite in original sealed package.

N.R.—Not Recommended.

Approximate roll-film equivalents in determining useful life of processing solutions:

2 Rolls 127 = one 8 x 10 sheet
1 Roll 135 (36-exp) = one 8 x 10 sheet
1 Roll 620 (120) = one 8 x 10 sheet
1 Roll 616 (116) = one and a half 8 x 10 sheets
1 Roll 122 = two 8 x 10 sheets

SOLUTION	KEEPING PROPERTIES WITHOUT USE				USEFUL CAPACITY
Stop Baths	TRAY	GALLON TANK	STOPPERED BOTTLE 65F	75F	8 x 10-INCH SHEETS PER GAL TRAY OR TANK
Kodak Indicator Stop Bath	3 Days	1 Mo	Indef	Indef	80
Kodak Universal Stop Bath	3 Days	(Not intended to be bottled and stored)			2 per packet
Kodak SB-1	3 Days	1 Mo	Indef	Indef	75
Kodak SB-1a	3 Days	1 Mo	Indef	Indef	40 (With D-8)
Kodak SB-3	1 Day	1 Mo	Indef	Indef	25
Kodak SB-4	1 Day	1 Mo	Indef	Indef	25
Kodak SB-5	3 Days	1 Mo	Indef	Indef	50
Kodak SB-5a	3 Days	1 Mo	Indef	Indef	100

Fixing Baths	TRAY	GALLON TANK	STOPPERED BOTTLE 65F	75F	8 x 10-INCH SHEETS PER GAL* WITH STOP BATH
Kodak Acid Fixer	1 Week	1 Mo	3 Mo	2 Wk	100
Kodafix Solution	1 Week	1 Mo	2 Mo	2 Wk	120 neg. (1:3) 100 prints (1:7)
Kodak Rapid Fixer (with hardener)	1 Week	1 Mo	2 Mo	2 Wk	120 neg. (1:3) 100 prints (1:7)
Kodak Photo Fix	1 Week	1 Mo	3 Mo	2 Wk	75 neg. 100 prints
Kodak F-5	1 Week	1 Mo	3 Mo	2 Wk	100
Kodak F-6	1 Week	2 Mo	3 Mo	3 Wk	100
Kodak F-7	1 Week	1 Mo	3 Mo	2 Wk	120
Kodak F-24	1 Week	1 Week	3 Mo	2 Wk	100

Hardeners	TRAY	GALLON TANK	STOPPERED BOTTLE 65F	75F	8 x 10-INCH SHEETS PER GAL TRAY OR TANK
Kodak Liquid Hardener					
Stop Bath	3 Days	1 Mo	Indef	Indef	80
Fixing Bath	1 Week	1 Mo	3 Mo	2 Wk	100

Toners	8 x 10-INCH SHEETS PER GAL TRAY OR TANK
Kodak Rapid Selenium Toner	100
Kodak Brown Toner	150
Combined Selenium and Brown Toner, No. 1	80
No. 2	40
Kodak Sepia Toner	160
Kodak Blue Toner	60

Intensifiers and Reducers	TRAY	STOPPERED BOTTLE 65F	8 x 10-INCH SHEETS PER GAL TRAY OR TANK
Kodak Chromium Intensifier		2-3 Mo	80
Kodak Farmer's Reducer	10-15 Minutes	2-3 Mo (Stock Sol)	
Kodak Reducer & Stain Remover		2 Mo	20
Washing Aids			
Kodak Hypo Clearing Agent		3 Mo	

*The useful capacity of a fixing bath can be increased by use of the two-bath system described on page 25.

DEVELOPMENT FOR NORMAL USE—KODAK SHEET FILMS AND PLATES

Kodak Sheet Films	Recommended Kodak Developers and Development Times at 68F (20C)—Tank* Agitation at one-minute intervals	Kodak Safelight Filter Wratten Series
NON-COLOR-SENSITIZED		
Commercial (also Matte)	DK-50 (1:1), 5 min; D-11, 8 min (tray)	
ORTHOCHROMATIC		
Super Speed Ortho Portrait	DK-60a, 4¼ min; DK-60a (1:1), 8 min; DK-50, 5 min; DK-50 (1:1), 10 min	2
Commercial Ortho	DK-50, 4¼ min; DK-50 (1:1), 6 min; D-11, 8 min (tray)	2
Contrast Process Ortho	Maximum contrast: D-8 (2:1), 2 min (tray); High contrast: D-11, 5 min	1
Royal Ortho	DK-60a, 4 min; DK-50, 5 min	2
PANCHROMATIC		*Total Darkness*†
Panatomic-X	D-76, 11 min; DK-50, 4¼ min; Microdol, 14 min; DK-20, 16 min	
Super-XX Panchromatic	D-76, 11 min; DK-60a, 4¼ min; DK-50, 6 min	
Portrait Panchromatic	DK-60a, 4¼ min; DK-50, 5 min; DK-50 (1:1), 9 min	
Contrast Process Panchromatic	Maximum contrast: D-8 (2:1), 2 min (tray); High contrast: D-11, 5 min	
Tri-X Panchromatic	DK-60a, 5 min; DK-50, 7 min	
Super Panchro-Press, Type B	DK-50, 5 min; DK-60a, 4¼ min	
Royal Pan	DK-60a, 4 min; DK-50, 5 min	
Royal-X Pan	DK-50, 7 min; DK-60a, 6 min	
INFRARED-SENSITIVE		
Infrared	D-76, 8 min; Microdol, 9 min; DK-20, 9 min; DK-50, 9 min	7
Kodak Photographic Plates		
NON-COLOR-SENSITIZED		
Process	Maximum contrast: D-8 (2:1), 2 min (tray); High contrast: D-11, 5 min	1
Lantern Slides, Medium	Versatol (1:3), Dektol (1:2), or D-72 (1:2), 1-3 min (tray)	1
Contrast Anti-Abrasion Contrast	Versatol (1:3), Dektol (1:2), or D-72 (1:2), 2-6 min (tray)	1
33: 33 Matte	DK-50 5 min; Maximum contrast: D-11, 8 min (tray)	1
ORTHOCHROMATIC		
Super Ortho-Press	Commercial: DK-60a, 4 min; DK-50, 5 min	2
Metallographic	Low contrast: D-41, 5 min; Medium contrast: D-41, 8 min; High contrast: D-42, 5½ min; DK-50, 8 min; Very high contrast: D-19, 8 min	2
PANCHROMATIC		*Total Darkness*†
Panchromatic and Panchromatic Matte	Contrast; D-76, 9 min; DK-50, 4 min	
M	Low Contrast: D-41, 5 min: Medium contrast: D-41, 8 min; High contrast: D-42, 6½ min; DK-50, 8 min; Very high contrast: D-19, 6½ min	
Super Panchro-Press	DK-60a, 4 min; DK-50, 5½ min	
Tri-X Pan, Type B Tri-X Pan, Type B, Matte	General photography: DK-50, 5 min	
INFRARED-SENSITIVE		
Infrared-Sensitive	Average contrast: D-11 (1:1), 4½ min; Maximum contrast: D-11, 8 min	7

*Tray development with constant agitation requires about 20% less time than tank development, except for those developers for which the tray dilution is different from the tank dilution as specified with each formula.

†See footnote on next page.

DEVELOPMENT FOR NORMAL USE—KODAK FILMS AND PAPERS

Kodak Films	Recommended Kodak Developers and Developing Times at 68F (20C)—Tank* Agitation at 30-second intervals	Kodak Safelight Filter Wratten Series
ROLL FILMS		Total Darkness†
Verichrome Pan	D-76, 12 min; Microdol, 12 min; Universal M-Q (32 oz.), 6 min Versatol (1:15), 9 min	
Panatomic-X (also 828)	D-76, 7 min; Microdol, 8 min	
Tri-X Pan	D-76, 11 min; Microdol, 11 min; DK-50, 6 min; DK-60a, 3¾ min	
Royal-X Pan	DK-50, 6 min; DK-60a, 5 min	
135 AND 828		
Panatomic-X (135)	D-76 (1:1), 7 min; Microdol, 6 min	Total Darkness†
Plus-X Pan (135)	D-76 (1:1), 8 min; Microdol, 7 min	
Verichrome Pan (828)	D-76, 8 min; Microdol, 10 min	
Tri-X Pan (135 and 828)	D-76, 11 min; Microdol, 11 min; DK-50, 6 min; DK-60a, 3¾ min	
Infrared (135)	D-76, 8 min; Microdol, 9 min; DK-20, 9 min	7
FILM PACKS (large tank—Agitation at one-minute intervals)		Total Darkness†
Verichrome Pan	D-76, 14 min; Microdol, 14 min; Universal M-Q (32 oz.), 7 min Versatol (1:15), 10 min	
Tri-X Pan	D-76, 13 min; Microdol, 13 min; DK-50, 7 min; DK-60a, 4¼ min	
SPECIAL PRINTING FILM		
Translite Opalure Print Film	Selectol (1:1) or D-52 (1:1), 2 min	0A

Kodak Papers	Recommended Developer and Dilution	Time in Seconds at 68F (20C)	Time Range Seconds	Safelight Filter
CONTACT PAPERS				
Azo Illustrator's Azo	Dektol (1:2), D-72 (1:2), Versatol (1:3) Ektonol (1:1), Selectol (1:1) Selectol-Soft (1:1), D-52 (1:1)	60 120	45 to 120 90 to 240	0A, 0C 0A, 0C
Aristo Athena	Ektonol (1:1), Selectol (1:1), D-52 (1:1) Selectol-Soft (1:1)	120	90 to 240	0A, 0C
Ad-Type Velox	Dektol (1:2), D-72 (1:2), Versatol (1:3)	60	45 to 120	0A, 0C
Velox Rapid	Dektol (1:2), D-72 (1:2)	60	45 to 120	0A, 0C
Resisto	Dektol (1:2) D-72 (1:2), Versatol (1:3)	60		0A, 0C
Velite	Dektol (1:2), D-72 (1:2), Versatol (1:3) Universal M-Q, Tri-Chem Pack	60	45 to 120	Use room lights
CONTACT OR ENLARGING PAPERS				
Opal Illustrators' Special Ektalure	Ektonol, Selectol, or D-52 (1:1) Selectol-Soft (1:1)	120	90 to 240	0C, 0A
Panalure	Selectol or Selectol-Soft (1:1) Dektol (1:2)	120 90	60 to 180 60 to 180	Series 10
Polycontrast	Dektol (1:2), D-72 (1:2)	90	60 to 180	0C, 1A
ENLARGING PAPERS				
Portrait Proof	Ektonol (1:1), Selectol (1:1), D-52 (1:1) Selectol-Soft (1:1)	120	90 to 240	0C, 0A
Kodabromide	Dektol (1:2), D-72 (1:2), Versatol (1:3)	90	60 to 180	0C, 0A
Medalist	Dektol (1:2), D-72 (1:2), Versatol (1:3) Ektonol (1:1), Selectol (1:1) Selectol-Soft (1:1), D-52 (1:1)	60 120	45 to 120 90 to 240	0C, 0A 0C, 0A
Mural	Dektol (1:2), D-72 (1:2) Ektonol (1:1) Selectol (1:1), Selectol-Soft (1:1), D-52 (1:1)	60 120	45 to 120 90 to 240	0C, 0A 0C, 0A
Resisto Rapid	Dektol (1:2) D-72 (1:2) Versatol (1:3)	60		0C, 0A
Polycontrast Rapid	Dektol (1:2), D-72 (1:2)	90	60 to 180	0C, 1A
Velox Premier	Dektol (1:2), D-72 (1:2)	60	45 to 120	0C

*Tray development requires about 20% less time than tank development except for those developers for which the tray dilution is different from the tank dilution as specified with each formula.

†*Total Darkness*—A Kodak Safelight Filter, Wratten Series 3 (dark green), in a suitable safelight lamp with a 15-watt bulb can be used for a few seconds *only*, at 4 feet, after development is half completed.

Developers

The line of Kodak developers fills the needs in all fields of photography. The developers suited to various purposes are summarized in the table below.

The instruction leaflets packed with Kodak photographic materials recommend the developers which, in general, have proved to be most satisfactory for the intended uses of each material. However, practically all Kodak film and plate developers can be used interchangeably, and the Kodak Developing Dataguide provides a convenient means for determining development times for combinations of films and developers for which no specific recommendations are given.

The different paper developers primarily effect changes in image tone and can be substituted freely if an exact image tone is not an important consideration. The image tones listed in the published descriptions of Kodak papers are the ones obtained with the primary developer recommendations.

Purpose	Recommended Kodak Developers	Approximate Development Times* (in minutes)	Remarks
Portrait	DK-50	5½	Most popular. Works well in tank or tray, with or without dilution.
	DK-50 (1:1)	8	
	DK-60a	4	Fast working. Has good keeping characteristics.
Commercial	D-76	16	Maximum speed and shadow detail. Produces long scale.
	DK-60a	5½	Long life, high capacity. Yields snappy negatives.
	DK-50	8	Excellent keeping. Produces good highlight detail.
Amateur	DK-60a	4	Short development time. Yields brilliant negatives.
	D-76	10	Maximum film speed. Gives moderately fine grain.
	Microdol	10	Fine grain, excellent quality. Has long life.
	Versatol (1:15)	9	Fast working. Supplied in convenient liquid form.
	Universal M-Q	6½	All purpose. Supplied in handy packets.
Pictorial	DK-50	8	Clean working. Produces good highlight detail.
	DK-60a	5½	Fast development. Yields brilliant negatives.
	D-76	16	Fullest emulsion speed. Gives maximum shadow detail.
	Microdol	16	Fine grain, clean working. Has long life.
Press	DK-50	7	Good capacity. Produces clean, crisp negatives.
	DK-60a	5½	Clean working. Gives moderately high contrast.
	Dektol (1:1)	3	Fast working. Yields high contrast.
	D-19	5	High capacity. Produces clean, crisp negatives.
Fine Grain	Microdol	10	Finest grain with minimum speed loss. Has long life.
Photo-finishing	Durol 7	7	For standard 7-minute machine and manual processing.
	Durol 10	10	For standard 10-minute machine processing.
	Microdol	12	For fine-grain development.
High Contrast	D-8	2†	Extremely fast. Gives maximum contrast and density.
	D-11	4†	Very high contrast. Suited to process work.
Printing and Enlarging	Dektol (1:2)	1-1½‡	For cold tones. Excellent clarity, high print capacity.
	Selectol (1:1)	2‡	For warm tones. High print capacity, long life.
	Selectol-Soft (1:1)	2‡	For warm tones. Soft results and good shadow detail.
	Ektonol (1:1)	2‡	For warm-tone papers.
	Versatol (1:3)	1-2‡	For general-purpose use. Comes in convenient liquid form.
	Universal M-Q	1-2‡	For general-purpose use. Comes in handy packet form.
	Dektomat	1-1½‡	For continuous paper processing machines. Has long life.

*Tank development, intermittent agitation, 68 F (20 C). For Kodak Tri-X Pan, Panatomic-X, Plus-X Pan, or Verichrome Pan Roll Film, or Super-XX or Portrait Panchromatic Film (in sheets) as recommended. Other films of higher or lower developing rates will have correspondingly shorter or longer development times. See data sheets for specific recommendations.

†Tray development of high contrast films, constant agitation, 68 F (20 C).

‡Tray development, constant agitation, 68 F (20 C). These are recommended times; they can be used satisfactorily in the range of from ¼ less to 2 times more than the recommended times.

KODAK MICRODOL DEVELOPER

Kodak Microdol is an excellent fine-grain developer unmatched for its ability to produce low graininess with minimum effect on emulsion speed and with relatively short time of development. It is free from sludge even when dissolved in hard water and does not form scum from use or aeration. A fine silver precipitate may form with use; this is normal and harmless. Microdol produces a very low fog level even with forced development of fine-grain films.

Development Recommendations: Average development time, 10 minutes in a tank at 68 F (20 C). See individual instruction sheets for specific recommendations.

Capacity: Without replenishment, 4 rolls of 620 roll film or 36-exposure 35mm film or equivalent (320 square inches) per quart. After the first roll has been developed, the development time must be increased 2 minutes for each succeeding roll developed in a quart, 2 minutes for each 4 rolls in a gallon, or 4 minutes for each roll in a pint. With replenishment, capacity is increased to 15 rolls per quart. Development time remains constant with replenishment.

Replenishment: *Small-tank*—Add 1 ounce per roll or equivalent (80 square inches) processed. *Deep-tank*—Add ¾ ounce per roll or 6 gallons per 1000 rolls (80,000 square inches) processed. See the discussion of replenishment on page 6.

Package Sizes: To make 16 ounces, 1 quart, 1, and 5 gallons. Thirty-eight and 48-gallon sizes are available on special order. Microdol Replenisher is available in 1-quart and 1- and 5-gallon sizes. Ready-to-use Kodak Microdol Liquid Developer is supplied in 1-quart bottles.

KODAK DEKTOL DEVELOPER

Kodak Dektol Developer is a prepared developer for producing neutral and cold-tone images on cold-tone papers. It remains unusually free from muddiness, sludge, precipitation, and discoloration throughout the normal solution life. It has high capacity and uniform development rate. Although best known as a paper developer, Dektol is also useful for rapid development of high-speed negative materials.

Development Recommendations: *Papers*—Dilute 1 part of stock solution to 2 parts of water. Develop Kodabromide, Polycontrast, and Panalure Papers about 1½ minutes, all other recommended papers about 1 minute at 68 F (20 C). *Films*—For rapid development of press films, see individual recommendations listed for each film.

Package Sizes: To make 16 ounces of working strength and 1 quart, and ½, 1, 5, and 25 gallons of stock solution. Fifty-gallon size available on special order.

KODAK SELECTOL DEVELOPER

Kodak Selectol Developer is a long-life developer specially designed for the development of warm-tone papers. It produces the same pleasing image tone and contrast as Kodak Developer D-52, remains clear during use, and has high development capacity and good keeping properties. Since the development activity decreases only very slowly with use, constant image tone is easy to maintain.

Development Recommendations: Dilute 1 part of stock solution with 1 part of water. For average results, develop 2 minutes at 68 F (20 C). For slightly warmer image tone, develop 90 seconds. Contrast can be increased slightly with some papers by developing up to 4 minutes. Increased development times will produce colder image tones.

Package Sizes: To make ½, 1, and 5 gallons of stock solution. Fifty-gallon size available on special order.

KODAK SELECTOL-SOFT DEVELOPER

Kodak Selectol-Soft Developer, except for what the name implies, is similar in all respects to Kodak Selectol Developer. It is recommended whenever results with Selectol Developer tend to be too contrasty for adequate shadow detail. Much softer results can be obtained than with regular Selectol, and there is no sacrifice in tonal scale. For a description of other characteristics, see the data given above for Kodak Selectol Developer.

Package Size: To make 1 gallon of stock solution. The stock solution is diluted 1 to 1 for use.

KODAK EKTONOL DEVELOPER

A non-carbonate developer which is particularly useful for the development of warm-tone papers which are to be toned. The development rate remains practically uniform throughout the useful life and thus holds the image tone constant from print to print.

Development Recommendations: Dilute one part of stock solution with one part of water. For average results, develop prints 2 minutes at 68 F (20 C).

Package Sizes: To make 1 and 5 gallons of stock solution.

KODAK DUOMAT DEVELOPER

A non-carbonate developer which is particularly useful for the development of cold-tone papers which are subsequently to be toned. While primarily intended for use in continuous processing machines, it can also be used for tray processing.

Development Recommendations: For use in a tray, add ½ ounce of Kodak Developer Starting Solution to each gallon of Kodak Duomat Developer. Use without dilution and develop about one minute at 68 F (20 C).

Package Sizes: To make 5 and 25 gallons of Kodak Duomat Developer. Kodak Developer Starting Solution is available in one quart size.

KODAK VERSATOL DEVELOPER

Kodak Versatol Developer is the ideal all-purpose developer for use with films, plates, and papers. It is packaged in convenient concentrated liquid form and stays unusually clear during use. Simply dilute with water for use. Versatol is especially handy for the amateur who uses several types of photographic materials but has limited storage space.

Development Recommendations: *Papers* — dilute 1 to 3; develop Kodabromide, Polycontrast, and Panalure Papers about 1½ minutes, other papers about 1 minute at 68 F (20 C). *Films and plates*—dilute 1 to 15 and develop Verichrome Pan roll film about 8 minutes at 68 F (20 C) in a tray or about 9 minutes at 68 F (20 C) in a tank. Dilute 1 to 3 and develop Kodak Lantern Slide Plates, Medium, 1 to 3 minutes and Kodak Lantern Slide Plates, Contrast, 3 minutes at 68 F (20 C) in a tray.

Replenishment: For replenishing film and plate developer used in a tank, dilute 1 part of Versatol with 3 parts of water and add ¾ ounce (22.5 cc) of this solution for each roll, or its equivalent (80 square inches), of film developed.

Package Sizes: Available in 8-ounce, 32-ounce, and 1-gallon bottles.

KODAK UNIVERSAL M-Q DEVELOPER

For the photographer who has little or no storage space or who uses small quantities of solution, Kodak Universal M-Q Developer is the ideal film and paper developer. Supplied in packets, Universal M-Q is economical and quick to prepare, and produces brilliant negatives and full-scale prints. Results are repeatable, since the developer is not intended to be stored, and a fresh batch is used each time.

Package Sizes: Available in a carton of 6 units, each unit sufficient to prepare 8 ounces of solution for tray development of papers or 32 ounces for tray or tank development of films.

KODAK TRI-CHEM PACK

The Kodak Tri-Chem Pack is an economical and easy-to-use combination package containing sufficient developer, stop bath, and fixer to process two rolls of film or fifty 2½ x 3½-inch prints or their equivalent. All of the chemicals are readily soluble and are packaged to make 8 ounces each of the three ready-to-use solutions. This quantity is adequate for an average evening's work and economical enough so that the solutions can be used once and then discarded. The pack has been designed for use as a unit, and it is not feasible to substitute different developers for use with the stop bath or fixer.

Package Size: Available in a carton containing 1 unit each of developer, stop bath, and fixer; each unit is sufficient to prepare 8 ounces of working solution.

KODAK DEVELOPER D-8

Kodak Developer D-8 is a fast-acting film-and-plate developer for process, line, and any other type of photography where very high contrast and density are desired (D-11 is recommended for general high-contrast work). D-8 can be used with both continuous-tone and process materials.

Prepared Package Sizes: To make 1 and 5 gallons.

Formula:

Stock Solution

	Avoirdupois—U. S. Liquid				Metric	
Water, about 90F (32C)	24	ounces	96	ounces	750	cc
Kodak Sodium Sulfite, desiccated	3	ounces	12	ounces	90.0	grams
Kodak Hydroquinone	1½	ounces	6	ounces	45.0	grams
Kodak Sodium Hydroxide (Caustic Soda)	1¼	ounces	5	ounces	37.5	grams
Kodak Potassium Bromide	1	ounce	4	ounces	30.0	grams
Water to make	32	ounces	1	gallon	1.0	liter

Dissolve chemicals in the order given. Stir the solution thoroughly before use.

For use, take 2 parts of stock solution and 1 part of water. Develop about 2 minutes in a tray at 68F (20C).

KODAK DEVELOPER D-11

Kodak Developer D-11 is a vigorous film-and-plate developer with good keeping properties, for general use where high contrast is desired. It is recommended especially for process and process panchromatic films or plates.

Prepared Package Sizes: To make 1 and 5 gallons. Larger sizes available on special order.

Formula:

	Avoirdupois—U. S. Liquid				Metric	
Water, about 125F (50C)	16	ounces	64	ounces	500	cc
Kodak Elon Developing Agent	15	grains	60	grains	1.0	gram
Kodak Sodium Sulfite, desiccated	2½	ounces	10	ounces	75.0	grams
Kodak Hydroquinone	130	grains	1 oz 90	grains	9.0	grams
Kodak Sodium Carbonate, monohydrated	1	ounce	4	ounces	30.0	grams
Kodak Potassium Bromide	75	grains	290	grains	5.0	grams
Cold water to make	32	ounces	1	gallon	1.0	liter

Dissolve chemicals in the order given.

For process photography, use without dilution. For development of copies of continuous-tone subjects, dilute with an equal volume of water. Develop about 5 minutes in a tank or 4 minutes in a tray at 68F (20C).

reflects so much light that photographically there are no deep shadows and the picture is to all intents and purposes flat. Of course, filters can be used to cut the effects of the haze and help record on the film the desired contrast—but that is another matter.

Once the photographer knows the kind of picture he wants to make and the type of subject he has to make it from, he can pick out the best developing technique to use.

How Developers are Classified

There are, of course, fine grain developers, and the opposite; developers that give good gradations, and the opposite; fast-working developers, and the opposite—but the classification which is of most interest at this time is on the basis of contrast. There are the high-contrast developers (e.g. hydroquinone-caustic soda) which give little or no shadow detail and terrific highlight density and are used for copying line drawings or printed matter. No formulas strictly of this type are given in this book, though Edwal-12 can be made to give very strong contrast, if desired by increasing the Monazol content to 8 or 10 grams per liter as described in Chapter III.

Then there are the average-contrast developers which give a long tone scale, with detail and gradually increasing density from one end of the scale to the other. On flat subjects or with soft lightings, these developers can be made to "pep-up" the contrast when necessary by increasing the time of development. With average (not too bright) lighting these developers produce full-scale negatives which print well, especially on the chlorobromide papers. In the northern United States the outdoor light is usually of this "average" variety (except in mid-summer) and hence most of the developers used then are of the "average-contrast" or full scale type. Edwal-10, Edwal-12, and Edwal-20 are examples, though Edwal-20 is somewhat softer working than the other two, especially after it has been used for 2 or 3 rolls per quart.

With very brilliant light, or on contrasty subjects the "average-contrast" developers produce so long a tone scale on the negative that the printing paper cannot record it. As a result there is blocking-up in the darker areas or loss of detail in the lighter areas or both. This can be cured by under-developing the film so as to shorten the tone scale on the negative. This, however, compresses the tone scale throughout its entire length so that the middle tones tend to "run-together" so to speak. Also, under-development causes some loss of emulsion speed. These disadvantages can be avoided by the use of one of the third class of developers, the "soft-working" type.

A "soft-working" developer produces a shorter tone scale than the "average-contrast" variety, not by compressing the tone scale throughout its entire length, but by shortening the steps at the upper end. For those who enjoy curves and graphs, this is most easily shown by superimposing the H. & D. characteristic curves produced by an average contrast developer (A) and a soft working developer (B) on the same film. It will be seen that, with the "soft-working" developer, in the brightest areas (where exposure is great) a given increase in exposure produces a smaller difference in density than with the "average-contrast" developer, though in the middle tones the two solutions act very much alike. Thus detail throughout the entire range is retained because the tone scale of the negative never gets so long that a printing paper cannot record it.

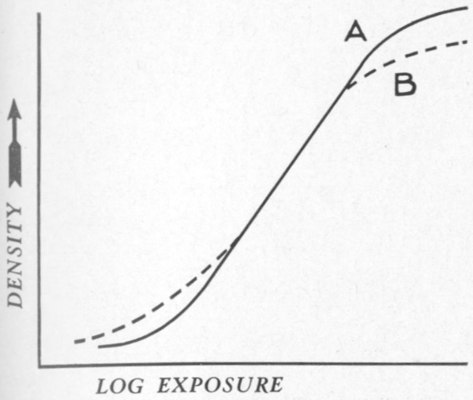


Fig. 13—Characteristic "H. & D." curves obtained by developing a film in (A) a full-scale developer such as Edwal-12 and (B) a soft-working developer such as Minicol.

Minicol, and to a lesser extent, Edwal-32, and Edwal-12 with the Monazol cut to 2 grams per liter are "soft-working" developers. These developers should be used in photographing contrasty subjects in brilliant light such as outdoor portraits in summer sunlight or most outdoor photography in southern United States and tropical countries. They are especially effective in photography of small near-by objects such as flowers, insects, rocks, and the like because over-development can be resorted to for emphasis of texture without losing detail through blocking up of the highlight areas. Of the developers mentioned, Minicol will give the finest grain, especially on the medium speed films. Edwal-32 runs a close second.

Specific Suggestions

It will be gathered from the foregoing discussion that generally speaking it is best to use an "average-contrast" developer with a soft or average-lighted subject, and a soft-working developer with a brilliant lighting. There are of course exceptions. Often, in stage photography for instance (where lighting is very contrasty) it is necessary to use a